HEREDITY.

BY JAMES THOMAS SEARCY, OF TUSCALOOSA,

Junior Counsellor of the Medical Association of the State of Alabama.

[FROM THE PUBLISHED TRANSACTIONS.]

1888.

HEREDITY.

BY JAMES THOMAS SEARCY, OF TUSCALOOSA,

Junior Counsellor of the Medical Association of the State of Alabama.

In the human species, heredity may be said to be the property possessed by two propagating cells, one furnished by each parent, which commingle together, and the resulting fused cell carries forward a combination of the characteristics derived from its two parental lines of descent.

Man is a sexed animal; for successful propagation there has to be a combination of cells from different sexes; separately the cells can not propagate. This is not the case with many lower forms of animal life, but it holds true with all the higher ones. The lowest forms are not sexed.

The different modes of propagation with all living beings, may be classed under three heads; first, by segments; second, by gemmation; third, by minute cells.

In propagation by segmentation the parent individual simply fissures, or divides into two or more parts, the parts, or segments being similar in size and structure to the parent. In propagation by gemmation the new individual is an offshoot, or bud from the body of the parent. In propagation by minute cells, the new individual, when first observed, is a simple uni-cellular being, which afterwards develops into a more or less complex being like the parent. Strictly speaking, all three of these modes of propagation are but variations of the original process by segmentation. Even the minute cells of the advanced orders of life are segments; their minute size and the exceeding concentration of their specialization have been

the obstacles to the early recognition of their functions, but modern science now fully admits them.

I have said that the higher orders of animals propagate by detachment from their bodies of minute highly specialized segments or cells. For the sake of clearness I prefer for them the name of *genetic-cells*. That genetic cell furnished by the female parent, I prefer to call the *germ-cell*, we usually call it the ovum; and that cell furnished by the male parent, which we usually call the spermatazoon, I prefer to call the *sperm-cell*. The genetic-cell of a female is a germ-cell, that of a male is a sperm-cell. Successful propagation in man requires the combination of a germ-cell and a sperm-cell. This is the case with all higher orders of animals. There are lower orders of animals whose genetic-cells will develop into adult individuals without combination with another cell. Such propagation a number of years ago was called *parthenogenesis* by Siebold. He derived the name from Parthenos, Minerva, or a virgin.

The evolutionary order in which propagation has advanced, according to the teachings of modern science, has been by segmentation first, then by gemmation or budding, then by more and more minute segments or cells. Parthenogenesis antedated sexed-genesis. Sexed animals have come on the stage of action as a variation from parthenogenetic.

By *gestation* we mean the carrying of the genetic cell to a point where it is capable of a separate existence. We have among animals *partheno-gestation* and *sexed gestation*. In the one case, the animal carries her own cell uncombined with that of another. In sexed gestation the female carries a combination of her germ-cell and a sperm-cell of a male. A definition of the terms male and female in this sense would be, the one does not gestate and the other does. The naturalists of to-day say that originally all animals were parthenogenetic, but the males have gradually acquired the faculty of not gestating their own genetic cells, but turn them over for gestation in combination with the cells of the female. In man and most other sexed animals the evolution of the sexes has become so distinct and decided, and the method of combined propagation

has been carried on so long, that the genetic cells do not now develop without combination. Still there are many lower varieties among whom, if the sexes are prevented from having access to each other the females will continue to propagate asexually. The male is said to be the varied and changed female. He has acquired the habit of not gestating, and consequently his gestating organs have become atrophied and useless. He always seeks the female for the purpose of depositing with her his sperm cells for gestation in combination with her germ cells. Therefore, we find the male in lower orders first losing their ability to gestate parthenogenetically; and for the same reason, we find the female holding on longer to the ability to propagate asexually; and even, it is said, we can discover in the females of very high orders the relics of this old habit. Among many sexed insects, parthenogenesis among the females is still possible. Among many birds, the females, if kept from the males, will still lay apparently well developed eggs, developed up to a certain point, but they fail to hatch because they do not originate from a combined cell. Even in woman there is said to be an attempt at parthenogenesis. She matures each month a germ-cell, and concomitant with its development the endometrium of the womb undergoes a certain degree of development preparatory for the gestation of the coming cell, but such is the effect of long continued ancestral habit the germ-cell can not develop without combination with a sperm-cell, so it perishes, and the whole procedure winds up in a miniature abortion, which occasions the menstrual flow.

In man and other mamalia the genetic cells of either sex can not long survive in any medium without combination; and after separation from the bed in the ovaries or testes in which they originate, they are seen to make very little if any further development until after combination.

The genetic-cell, apparently simple in structure and microscopically small, is a highly specialized structure. In this case, the specialization consists in the property the cell has, when placed in the proper medium, although exceedingly small, of repeating ancestral activities. Scientifically speaking, it has

the faculty under proper circumstances of reperforming the modes of molecular motion, the kinds of cellular action that have previously been performed by its ancestry. In other words, we observe that the genetic cell is a starting point of all those activities which, as it develops and grows, prove to be a repetition of the characteristic modes of action of its ancestry. In parthenogenetic propagation the resulting new individual is a repetition of a single line of descent; in sexed propagation, we observe the new individual to be a combination of the substances of the two genetic cells, and to exhibit in its modes of action a combination of their modes of action. Two parental lines of descent are combined in the embryo, and are gradually and successively unfolded in the fœtus, the infant and the adult.

In order that there be a successful combination of any two genetic cells it is obviously necessary that their modes of motion be harmonious; the kinds of action, in other words, that have been the evolutionary history of the two parental lines of descent of two animals have to be alike, or so very nearly alike that their differences are very slight, before there can be a harmonious or successful combination of the two cells. One cell specialized to repeat the kinds of cellular action that go to assume the shapes and functions of the different organs and parts of a horse cannot combine in harmonious action with the genetic cell that has as its specialization the assumption of the parts and functions of a cow. Their lines of evolutionary descent have been separated into different species so long ago, and their modes of action are so different, that there is now not sufficient similarity of action for the successful combination. This is not the case though with the horse and the ass. The sexes of widely separated species of animals cannot propagate for this reason.

The essential or potential part of each genetic cell seems to be the central portion, analagons to the nucleus in all other cells. This central substance, amorphus in shape and structure, is like the lowest form of living substance, protoplasm, and is called spermatin by microscopists because of its peculiar

mode of staining; and yet, as a matter of observation, it proves to be the part that carries the specialization. It has received and holds for future repetition the impressions of all previous actions of its history, or of its historical evolution.

For successful propagation it is necessary that the nuclei of the two genetic cells should gain access to each other. The nucleus is situated about centrally in the germ cell, and just behind the head in the caudated sperm-cell.

On fusion of the two genetic cells or of their two nuclei, we witness the central primary substance to begin at once to assume a series of acts which result in the formation of a number of secondary structures, which exhibit in more or less accurate detail previous functions and actions of ancestral history. Says Brooks, "the starting cell gives rise during the process of segmentation to a number of cells, which gradually become specialized for different functions, and thus arise the organs of the body." I need but refer to modern writings on all subjects relating to zöology to find expressions similar to the following, which I quote because it is concise: "We know from a mass of evidence which is constantly and rapidly increasing, and to which each new observation adds cumulative weight, that the various forms of life have been slowly evolved, during long ages, from older and simpler forms." * * * "That complete knowledge of the ancestry of any organism would lead us back through simpler and simpler forms to a remote unspecialized uncellular ancestral form."

Again, Hackel says, and I could quote the same ideas from a number of other writers: "Until recently the greatest students of embryology, Wolf, Baer, Remack, Schleiden, and the whole school of embryology founded upon them, have regarded the science as exclusively the study of individual development. Far otherwise to-day, when the wonderful histories of the development of individual organisms no longer face us as an incomprehensible riddle, but have clearly revealed their deep significance; for the changes of form which the germ passes through under our eyes in a short time are by the law of inheritance a condensed and shortened repetition of the corres-

ponding changes of form which the ancestors of the organism in question have passed through in the course of many million years. To-day, when we lay a hen's egg in an incubator and in twenty-one days see the chick break out of it, we no longer gaze in dumb wonder on the marvelous changes which lead from the simple egg to the layered gastrula, from this to the worm like and skull-less germ, and from this to later stages, which repeat essentially the organizations of fish, amphibian, reptile, until at last we have a perfect bird. On the contrary, we unravel from this history the corresponding series of ancestral forms which have led up through the amœba, the gastrea, the worms, the acrania the fishes, the amphibia, and the reptiles to the bird." "This ancestral or phylogenetic significance of the phenomena of autogeny, or individual development, is up to the present time the only explanation of the latter." Says Brooks, "No one can set too high a value upon the scientific law here expressed—that individual development is a recapitulation of the history of the evolution of the species."

From all I have been saying, we see that the propagating cell has the specialty of repeating ancestral activities, and this specialty or property is what we call heredity.

In the genetic cell of man the specialization of the repetition of ancestral activities is an exceedingly complex chapter. It has led up through a long ancestral line. In common with other animals, whole cycles of history are condensed and shortened into a few weeks and months of embryonic and fœtal life. In the separate existence of his individual and personal life in society also, ancestral habits are stamped upon his modes of action; and are shown in the assumption of ancestral organs and parts so as to exhibit their shapes, forms and likenesses; and also are seen to reach up into most recently acquired modes of action and exhibit ancestral traits of conduct, character and intelligence.

In all animal life each new individual starts its existence from the bottom of the ladder; those earlier parts of its history that have been performed over and over again, million on

million of times, by virtue of familiar habit, it executes rapidly and condenses into a short space of time, while those activities more recent and more advanced and more complex it executes more and more slowly.

All physiological and all pathological heredity find their ready answer in the modern scientific enunciation, that it is the property of a certain detached portion of the body of one person to take up from the beginning all the characteristics of its ancestry and repeat them; and this second individual has this same property of detaching segments of itself, with the same faculty continuing through succeeding generations. Each new member is actually a part of the preceding, living again. Nothing is more true than the old adage that "the parent lives over again in the child."

Man is very distinctly and decidedly sexed. Parthenogenesis has long since disappeared. There is only a slight tendency towards that process in the female. There is a commingling of the structures of the two cells and a communion of their activities. Such expressions, which we find very current in our medical literature, referring to the new embryonic being as a "vitalized," "vivified," "fertilized" ovum, are misleading, and should now become obsolete. They are relics of the old belief that the spermatic fluid is only a pabulum for the ovum, which alone carries the beginning germ. The fact is, one cell is as much "fertilized" as the other.

A great deal has been said in answer to the question—What *determines the sex* of the offspring in sexed animals? What determines in the combined cell whether the child shall be male or female? In the combination of the sperm-cell with the germ-cell, what transmitted potentialities, what preponderance of specialty comes over with one or the other, that leads the resulting activities of the new cell to tend in one case to the development of an individual who has its organs for gestation fully matured, in the other case to one whose organs for gestation are atrophied and useless?

Most naturally we would suppose in the fusion of a sperm-cell and a germ-cell, that each one would carry forward into

the communion the specialties and peculiarities of its particular parent; that is, the germ-cell of the mother would tend in its modes of action to produce a female, and the sperm-cell of the father would be potent in the modes of its action to assume the peculiarities of a male; and in the commingling of potentialities, the one most potent would determine the sex. As the genetic-cell, in other words, is a representative of ancestral activities, that parent who in his or her person is the result or the embodiment of most action, would produce a more potential propagating cell, and the amount of action it carried over into the combination would be a result of the amount of activity and exercise, cerebral, muscular and otherwise, that had been performed in the parent's own life and that of his or her ancestry.

Strength or capacity for action comes in no other way but by previous action or exercise. The balance of power in the fusion of the two cells, which would determine the sex, would lie with that cell whose ancestral activity or exercise had been the greatest. In those cases where the amount of ancestral activity on both sides was about the same, we might easily suppose that cell whose individual life had been the most favorable would be best developed and the most potent. The favorable or unfavorable position it held in the ovary or the testis, that is, the amount of space it had and nutriment, or the time it had for its full maturity before detachment, would all be factors in its own history that would lead to a more potent condition, independent of ancestral activity and strength; in those cases where ancestral activity is about the same, such elements would have to be considered.

The method of determination of sex I have just been describing, is what we may call direct heredity, from father to son and from mother to daughter, but a large number of close observers, and so far as my information extends, the majority believe in what is called *cross-heredity*, in which the tendency of the sperm-cell is to the formation of a female, and of a germ-cell to that of a male. The direct tendency of heredity, under this view, is alternating; the father produces a

sperm-cell which is female, and the mother produces a germ-cell which is male. There is an alteration in the function of gestating and non-gestating in direct descent. There is no way among the strongly sexed animals of maturing a genetic cell, uncombined, in order to determine this question, but a great deal of observation has been made upon the combined cell to see in which direction the preponderance of peculiarities or characteristics run; whether in the direction of direct heredity, from father to son and from mother to daughter, or of cross-heredity, from father to daughter and from mother to son.

Says Ribot: "When we study heredity, when we observe facts and generalizations which immediately result from it, the formula which includes the largest number of facts and admits of the fewest exceptions is the following; heredity passes from one sex to the opposite. This assertion may at first appear strange, even entirely at variance with what has already been said, that like produces like. * * * * But probably it will appear less difficult of comprehension if we follow heredity through several generations. It will then be seen to pass from grandfather to mother and from mother to son; or from grandmother to father and from father to daughter." Again, he says, "Cross-heredity is very common when parents are normal and healthy. When one of them has any deformity or anomaly, cross-heredity is still more common; lameness, rickets, sexdigitism, in short, all organic imperfections pass most readily from fathers to daughters and from mothers to sons." Richerand says, "This explains why so many great men have mediocre sons." Many can be found advocating both sides of the question. I believe the weight of evidence leans towards cross-heredity. Many cases are cited of crosses between wild and tame animals where the males are like the mother and the females resemble most the father. Hunters have a saying, "Dog from bitch and bitch from dog," and stock breeders consider the maternal side of the pedigrees of their stallions and bulls of highest importance.

I shall leave this question of the determination of sex .by

citing the case of the honey-bee as an example pointing to cross-heredity. The bee is the only partly parthenogenetic animal that we have domesticated, and whose habits are therefore open to frequent observation and study. Among them, the workers are sterile females; they are sometimes seen to bear parthenogenetically eggs which always hatch out drones or males. They are therefore often called "drone mothers." On the other hand, the receptaculum seminis of the only fully developed female, the queen-bee, is very large, capable of retaining the seminal fluid of all the drones, or of many of them. Copulation only occurs during flight, when the bees are said to be "swarming," after which the receptacle of the queen is found filled with the sperm-cells of the males in countless numbers. The vast majority of eggs which are deposited and hatched out from this great excess of male cells prove to be the workers or sterile females. We may reasonably suppose that only a few meet with the germ-cells of the queen and become fully developed and sexed like other animals; but the receptacle in the case of the bee, proving to be a nidus for the others, they form partially developed females and become the workers. When a queen-bee has become too old, or has become maimed, so that she cannot make her copulating flight, she then sometimes bears parthenogenetic eggs, which always hatch out males.

Many kinds of insects are known to be able to gestate or reproduce parthenogenetically. Decidedly sexed males never gestate. When males apparently do so, it is in those low orders where the sexes are not yet sufficiently differentiated. And again, the genetic cells of some animals leave their bodies so little developed that it can hardly be called gestation at all. Confusion is liable to arise from these causes.

However the question of determination of sex may be finally decided, whether by direct or by cross-heredity, it is reasonable to suppose that the more potent cell in the combination carries the determination, and that the potency of the cell is due to and is commensurate with the amount of previous activity in the lines of its parental ancestry. The exceptions to this rule

may be said to be due to a near balance in the two parental lines, and that the individual life-history of the cell itself has given rise to a better developed cell in one case than in the other. Cells from the same parent will differ for this reason. But the rule is, the more potent parent will bear the majority of potent cells, and will determine the sex in the majority of cases.

Male and female differences and peculiarities are observable in all orders of sexed animals. The female is usually called the weaker member. In all those organs and parts which are not specially sexual, while there is generally a close resemblance and similitude in shape, structure and function in the two sexes, still there is usually sufficient difference to make plain the distinction between them. What has made these differences, is a much asked question. The servitude of the female, and her subordination to the superior strength of the male, has been the argument usually used to account for them. Such an argument begins by assuming that the male is the central or leading character in the evolution of the species, and that the sexes, originally alike and equal in all but purely sexual organs, the female has varied by degeneration from her original position on account of her subjection by the male.

Recent scientific generalization offers a very much more satisfactory explanation, and one that conforms to all of the observed facts of the case, that the male is the variation from the original type. That he has gradually assumed the role of non-gestation, and all the leading non-sexual differences between the sexes have arisen from this source.

It is very easy to see how, during the gradual evolution of the race, when one set of individuals assume the habit of not gestating their own genetic cells, that they are freed from many of the duties and cares of their parthenogenetic companions, and are allowed a much more varied field of action. Gestation necessitates that the animal be more or less confined and impeded in general locomotion and general variety of action.

Parthenogenesis was a very marked step in advance, a vast improvement over gemmation and segmentation; the assumption of sexes was a still more advanced acquisition, and led to a much more rapid race progress. The non-gestating individual has a greater liberty of motion, and this brought him at once in conflict with a much more extended and more varied environment, and necessitated his assuming new actions to meet the exegencies of his new surroundings; this in time gave rise to new and more advantageous acquisitions on his part, which were transmitted to succeeding generations and led to the improvement of the race. Sexed animals, or the assumption by certain individuals of the faculty of not gestating their genetic cells, was a decided step in advance, and we find sexed races holding the highest positions. The more advanced orders are all sexed.

It has been often remarked by naturalists that the male is the more varied member. He varies from the female type in the first place in having his maternal organs, uterus, mammary glands, etc., atrophied and useless, they have become so by disuse. But besides a difference in sex organs we find the males to have acquired different and more varied functions in all those organs that are naturally perfected by competition and conflicting contact with the activities in the world around them; for instance, in cerebral and muscular functions. If we say the male is the more successful animal of the two as a rule, we mean he is more capable in competitive ability, and his excellence in these particulars has arisen because he is not weighted down by gestation and cares of maternity, and is gradually and more rapidly developed in successful, that is, competitive lines; and we state, with abundant proof to confirm the assertion, that those races are the most rapidly advancing in which the males are decidedly variable. Among men, they are progressive and aggressive. They vary to suit their surroundings quickly, promptly and efficiently. When the men lapse into "effeminate" habits, that race is not progressive, but is usually degenerating. Sexuality is a great natural "division of labor," and like all "divisions of labor," has led to much more efficient action.

The world is full of illustrations of male variation. Darwin says, "The weapons for battle, organs for producing sound, ornaments of many kinds, bright and conspicuous colors have generally been acquired by the males." All about us we can find illustrations of this fact. Among insects the males have the more varied colors, ornaments and weapons; among birds, the same is the case; and the same holds true among many animals of more advanced orders. Young males are like the ideal type of the race, are like females. When the young males begin to assume sexual functions, they take up or put on their different variations. Among some closely allied species of animals the females are very much alike, while the differences between the species are best shown by the males. The females of some birds of nearly related species, are very much alke while the males are very different. Darwin found some species of butter-flies in South America among whom the females were nearly exactly alike, while the males were so unlike that they looked like they belonged to widely separated species, and it was only after very close observation he found the sexes were of the same species.

The development of the cerebrum in man is his most distinguishing or most successful acquisition. It makes his great feature, distingnishing him from lower animals; and makes the chief excellence in the successful races of men compared with the others. Cerebral development and cerebral excellence is the feature in man to be most desired and to be most cultivated. Peculiar traits of cerebral or mental action can be shown to mark the differences between men and women. The osseous and muscular development is different, and so are the modes of cerebral action, and the mental differences partake of this same general character that is characteristic of the sexes throughout the whole class of sexed animals; the males vary most.

The females among lower animals are the more stable in colors and shapes; in like manner among men, the woman is the least variable and most constant in all mental attributes. While she is not the most inventive, aggressive, and as we say,

progressive, she is more fixed, stable, and constant; true to traditions, habits, fashions and customs of society. She is less sinful, less vicious on this account, and more moral, more constant, more consistent, more conservative, more religious. Whatever is established as a race custom she follows.

The principles of physiological heredity I have now enunciated. Pathological heredity, like all other pathology, is no more nor less than defective or disturbed or disordered physiology. The abnormal actions of diseases called hereditary are modes of defective action transmitted in the same manner that normal modes are. The off-shooting genetic cell bears the tendency, or is "specialized," by reason of ancestral defective action, first, to assume defective modes of morphological action, that is, to arrange the structures of certain organs by defective modes; and secondly, to have as a consequence defective functional action or defective physiology. Strength, or tone of cellular action, in any structure or organ, is in accordance with ancestral action, unless diverted by unusual or accidental action from outside. Defects or deformities are often congenital, by accident occurring during embryonic or fœtal life, after the combination of the parental cells; but, the largest part of all such aberrations, and to which alone we ought to ascribe the term hereditary, are those that are repetitions of defective ancestral modes. Embryonic or fœtal accidents are congenital but not hereditary, no more hereditary than many other accidents or diseases that occur after birth. Most diseased conditions that show themselves in the life of the person, as troubles that we call hereditary, are in reality due to atonic or weak parts, the results of ancestral weakness, and the diseases are simply the breaking down or giving way of the parts; because of their inherent weakness such organs are more easily affected by disturbing causes, such as bacteria, changes of temperature, over-work, etc., etc.

A large part, the greater part of the work of the medical

profession has heretofore been to treat the "unfit" members of society, and such effort, to come down to an unsentimental view of it, not only largely spends itself in the preservation of such persons but by not allowing them to disappear according to natural courses, continues them to propagate their unfitness. Not, by any means to under-rate in its highest sense such work, nor to abate effort in this direction, I would still draw attention to the other and higher field of effort in the direction of increasing the proportionate number in society of the "more fit." This has been heretofore left altogether to natural causes. The very select, and the very few "fittest" members of society, have come to the top without any methodical effort to increase their number. There is very much methodical work in society to preserve and continue the "unfit," but little or none to increase the proportion of the "fittest."

Did you ever undertake to compute the rapid disappearance of the human family? Did you ever work out the easy problem of allowing a very reasonable number of children, say five to every married couple, and estimate how few generations it would take, if all survived to a reasonable age, at that ratio, to fill the world to overflowing? How soon, at that rate, would there be "standing room" in most communities.

Some philosophers, now-a-days, are even advocating the "economic value of vice." They consider that there is a necessity for vicious usages to rid society of the incubus of its unfit membership. The less capable are more rapidly purged out in "the struggle for existence;" they argue, if every one had abundant capacity and were not vicious, the world would soon grow too populous.

Those communities and those nations are the most successful who have the largest proportion of capable persons. In competitive lines of work, which I say are the kinds to develop successful individuals and families and races, muscular, and especially cerebral exercise and effort is required. Exercise of these organs is the *sine qua non* for improvement. Individual increase of capacity and hereditary improvement only lie along the road of exercise. Activity is the watchword to success; and cerebral activity more than any other.

Human cerebral capability is a very unstable function, probably less fixed and stable than any other function of the body. A high degree of excellence is only secured and maintained by continued effort or exercise. It is only reached by ancestral and individual effort, and is only kept at a high level by continued exercise.

Apparently in modern society, the object of effort is to reach such a degree of competency, that one's children after him at least, will not have to strive or work. When excellence, by its superiority, has reached such degree of competence that further effort is deemed unnecessary, at once we see degeneracy set in. Successful men are seldom followed by successful families. The wives and families of successful men, in the city particularly, live in idleness. The sons of such mothers by cross-heredity are less capable. Excellent parents make great sons, not so much by the training they give them, as by the efficient character of the cerebral activity they transmit to them. We see few great men come from the successful families in the cities, but we see them rising from busy-brained, working mothers in the back country. I believe in cross-heredity to the extent that I think we are working in the best direction when we study the maternal more than the paternal side of a great man's lineage for the secret of his success. It is true, the combination is a mutual one, but, if there is any excess, the preponderance of heredity lies on that side of parentage in sons. In daughters it is on the other side.

The summation of it all is, superiority, cerebral or muscular, is only due to previous continuous action; improvement comes by action; degeneracy by non-action.